CERTIFICATION OF TRANSLATION

I, ***Eun-Sook Lee***, an employee of Y.P.LEE, MOCK & PARTNERS of Koryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalty of perjury that I understand the Korean language and the English language; that I am fully capable of translating from Korean to English and vice versa; and that, to the best of my knowledge and belief, the statement in the English language in the attached translation of ***Korean Patent Application No. 10-2003-0002092*** consisting of 43 pages have the same meanings as the statements in the Korean language in the original document, a copy of which I have examined.

Signed this 12th day of July 2007

E.S

ABSTRACT

[Abstract of the Disclosure]

Provided are a defect management method using a temporary defect management area and an apparatus and disc therefor. The write once disc is a disc with at least one record layer on which a lead-in area, a data area, and a lead-out area are sequentially arranged, and includes a defect management area formed on at least one of the lead-in area and the lead-out area; and a temporary defect management area formed on at least one of the lead-in area and the lead-out area, wherein the temporary defect management area is an area in which temporary defect information indicating only information regarding defects generated during the corresponding recording operation, and temporary defect management information indicating information for managing the temporary defect information are recorded, and the defect management area is an area in which the temporary defect information and the temporary defect management information are respectively recorded as defect information and defect management information when finalizing. Accordingly, it is possible to perform disc defect management on a write once disc while effectively using a defect management area of the disc.

[Representative Drawing]

FIG. 6

SPECIFICATION

[Title of the Invention]

DEFECT MANAGEMENT METHOD USING TEMPORARY DEFECT MANAGEMENT AREA, AND APPARATUS AND DISC THEREFOR

[Brief Description of the Drawings]

The above and/or other aspects and advantages of the invention will become apparent from the following description of the embodiments, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a block diagram of a recording apparatus according to a preferred embodiment of the present invention;

FIG. 2 illustrates a structure of a disc according to a preferred embodiment of the present invention;

FIG. 3A illustrates a data structure of the disc illustrated in FIG. 2;

FIG. 3B illustrates an example of a temporary defect management area and a defect management area illustrated in FIG. 3A;

FIGS. 4A and 4B illustrate a data structure of the temporary defect management area, according to an embodiment of the present invention;

FIGS. 5A and 5B respectively illustrate data structures of temporary defect management information *TDDS #i* and a copy thereof;

FIG. 6 illustrates a data structure of temporary defect information *TDFL #i* according to another embodiment of the present invention;

FIG. 7 illustrates diagrams explaining recording of data in a user data area *A* and a spare area *B*, according to a preferred embodiment of the present invention;

FIG. 8 illustrate data structures of temporary defect information *TDFL #1* and *TDFL #2* recorded as illustrated in FIG. 7;

FIG. 9 illustrates a data structure of information regarding defect #i;

FIG. 10 is a flowchart illustrating a disc defect management method according to a preferred embodiment of the present invention; and

FIG. 13 is a flowchart illustrating a defect management method according to another embodiment of the present invention.

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art prior to the Invention]

The present invention relates to disc defect management, and more particularly, to a defect management method using a temporary defect management area (TDMA) and an apparatus and disc therefor.

Disc defect management is the process of rewriting data stored in a user data area of a disc in which a defect exists to a new portion of the disc's data area, thereby compensating for data loss caused by the defect. In general, disc defect management is performed using linear replacement or slipping replacement. In linear replacement, the user data area in which a defect exists is replaced with a spare data area having no defects. In slipping replacement, the user data area with the defect is slipped and the next user data area having no defects is used.

Both linear replacement and slipping replacement are, however, applicable only to discs such as a DVD-RAM/RW, on which data can be repeatedly recorded and recording can be performed using a random access method. In other words, linear replacement and slipping replacement are difficult to be applied to write once discs on which recording is allowed only once. In general, the presence of defects in a disc is detected by recording data on the disc and confirming whether or not data has been recorded correctly on the disc. However, once data is recorded on a write once disc, it is impossible to overwrite new data and manage defects therein.

After the development of a CD-R and a DVD-R, a high-density write once disc with a recording capacity of several dozen GBs was introduced. This type of disc can be used as a backup disc since it is not expensive and allows random access that

enables fast reading operations. However, disc defect management is not available for write once discs. Therefore, a backup operation may be discontinued when a defective area, i.e., an area where a defect exists, is detected during the backup operation. In general, a backup operation is performed when a system is not frequently used, e.g., at night when a system manager does not operate the system. In this case, it is more likely that the backup operation will be discontinued when because a defective area of a write once disc is detected.

[Technical Goal of the Invention]

The present invention provides a disc defect management method, apparatus and disc applicable to the write once disc.

The present invention also provides a defect management method, apparatus, and disc, in which disc defect management can be performed even when a disc defect is detected during a recording operation, thus allowing the recording operation to be performed without interruption, and a disc defect management method and apparatus therefor.

The present invention also provides a defect management method, apparatus, and disc, in which defect information can be effectively recorded, and a disc defect management method and apparatus therefor.

[Structure and Operation of the Invention]

According to an aspect of the present invention, there is provided a write once disc with at least one record layer on which a lead-in area, a data area, and a lead-out area are sequentially arranged, the write once disc including: a defect management area formed on at least one of the lead-in area and the lead-out area; and a temporary defect management area formed on at least one of the lead-in area and the lead-out area, wherein the temporary defect management area is an area in which temporary defect information indicating only information regarding defects generated during the corresponding recording operation, and temporary defect management information

indicating information for managing the temporary defect information are recorded, and the defect management area is an area in which the temporary defect information and the temporary defect management information are respectively recorded as defect information and defect management information when finalizing.

According to another aspect of the present invention, there is provided a write once disc with a first record layer on which a lead-in area, a data area, and a lead-out area are sequentially arranged, and a second record layer on which an outer area, a data area, and a lead-out area are sequentially arranged, the write once disc including a defect management area formed on at least one of the lead-in area, the lead-out area, and the outer area; and a temporary defect management area formed on at least one of the lead-in area, the lead-out area, and the outer area, wherein the temporary defect management area is an area in which temporary management information indicating only information regarding defects generated during the corresponding recording operation is recorded, and temporary defect management information including information for managing the temporary defect information are recorded, and the defect management area is an area in which the temporary management information and temporary defect management information recorded in the temporary defect management area when finalizing are respectively recorded as defect information and defect management information.

A plurality of areas exist in the same defect management area, and the temporary defect information and the temporary defect management information are recorded several times as pairs of information to be adjacent to each other in the temporary defect management area.

The temporary defect management information includes information indicating the location at which the corresponding temporary defect information is recorded, the temporary defect management information includes a pointer pointing out to the location of temporary defect information recorded right before the temporary defect management information, and a pointer pointing out to the location of a replacement for the defect.

According to yet another aspect of the present invention, there is provided a

method of managing disc defects, the method comprising (a) recording only information regarding a defect detected in data, which is recorded in a data area of a disc during a first recording operation, as first temporary defect information in a temporary defect management area; (b) recording management information for managing the first temporary defect information as first temporary defect management information in the temporary defect management area; (c) repeating (a) and (b) at least once while increasing indexes given to the recording operation, the temporary defect information, and the temporary management information by 1; (d) reading and writing all of recorded temporary defect management information and temporary defect information in a defect management area which is formed on at least one of the lead-in area, the lead-out area, and the outer area of the disc.

Operation (d) is performed after data according to a final operation is recorded in the data area. Operations (a) and (b) include repeatedly and sequentially recording the temporary defect information and the temporary defect management information as pairs of information to be adjacent to each other, several times, starting from the start or end of the temporary defect information area.

Operation (b) includes recording location information of corresponding temporary defect information, and location information temporary defect information recorded right before the corresponding temporary defect information, as the temporary defect management information.

Meanwhile, according to still another aspect of the present invention, there is provided a recording apparatus comprising a recording/reading unit that records data on or reads data from a disc; and a controller that controls the recording/reading unit to record information regarding a defect detected from data, which is recorded in a data area of the disc according to a recording operation, as first temporary defect information in a temporary defect management area which is formed on at least one of a lead-in area and a lead-out area of the disc, and to record management information for managing the temporary defect information, as temporary defect management information, in the temporary defect management area.

The controller controls the recording/reading unit in such a manner that the corresponding temporary defect information and temporary defect management information are recorded as pairs of information to be adjacent to each other.

The controller controls the recording/reading unit to read temporary defect information and temporary defect management information recorded in units of a recording operation when finalizing, and record the temporary defect information and temporary defect management information in a defect management area which is formed in at least one of the lead-in area and the lead-out area of the disc.

Also, according to still another aspect of the present invention, there is provided a recording apparatus comprising a recording/reading unit that records data on or reads data from a disc; and a controller that controls the recording/reading unit to record information regarding a defect detected from data, which is recorded in a data area of the disc according to a recording operation, as first temporary defect information in a temporary defect management area which is formed in at least one of a lead-in area and a lead-out area of the disc, to record defect management information for managing the first temporary defect information, as first temporary defect management information, in the temporary defect management area, to record data in the data area while increasing indexes allotted to the recording operation, the temporary defect information, and the temporary defect management information by 1, and to read and record the recorded temporary defect management information and the temporary defect information in a defect management area, when finalizing.

The controller controls the recording/reading unit to record data according to a final recording operation in the data area, and to read the recorded temporary defect information and temporary defect management information, as final defect management information and final defect information, in the defect management area which is formed in at least one of the lead-in area, the lead-out area, and the outer area of the disc. Also, the controller controls the recording/reading unit in such a manner that corresponding temporary defect information and temporary defect management information are sequentially recorded as pairs of information, in the temporary defect

management area, starting from the start or end of the temporary defect management area.

The controller controls the recording/reading unit to record the location information of corresponding temporary defect information, and the location information of temporary defect information recorded right before the corresponding temporary defect information, as the temporary defect management information.

Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below to explain the present invention by referring to the figures.

FIG. 1 is a block diagram of a recording apparatus according to an embodiment of the present invention. The recording and/or reproducing apparatus includes a recording/reading unit 1, a controller 2, and a memory 3. The recording/reading unit 1 records data on a disc 100, which is an information storage medium according to an embodiment of the present invention. The recording/reading unit 1 further reads back the data from the disc 100 to verify the accuracy of the recorded data. The controller 2 performs disc defect management according to an aspect of the present invention. In this embodiment, the controller 2 uses a verify-after-write method, in which data is recorded on the disc 100 in predetermined units of data and the accuracy of the recorded data is verified to detect if an area of the disc 100 has a defect. In other words, the controller 2 records user data on the disc 100 in units of recording operations, and verifies the recorded user data to detect an area of the disc 100 in which a defect exists. Thereafter, the controller 2 creates information indicating a position of the area with the defect and stores the created information in the memory 3. When the amount of the stored information reaches a predetermined level, the controller 2 records the stored information as temporary defect information on the disc 100. While described in terms of a recording apparatus, it is understood that the apparatus of FIG. 1 further reproduces data according to a further aspect of the invention.

According to an aspect of the invention, the recording operation is an operation unit determined according to a user's intention or a recording work to be performed. According to this embodiment, a recording operation indicates a process in which the disc 100 is loaded into the recording apparatus, data is recorded on the disc 100, and the disc 100 is taken out from the recording apparatus. During the recording operation, data is recorded and verified at least once. In general, the data is recorded and verified several times. Defect information obtained using the verify-after-write method is temporarily stored as temporary defect information in the memory 3.

When a user presses the eject button (not shown) of the recording and/or reproducing apparatus in order to remove the disc 100 after recording the data or the recording operation is otherwise designated as being completed, the controller 2 expects the recording operation to be terminated. The controller 2 reads the defect information from the memory 3, provides the defect information to the recording/reading unit 1, and controls the recording/reading unit 1 to record the defect information on the disc 100. In the shown example, the defect information is recorded as the temporary defect information on the disc 100 in recording operation units. The recording defect information in the recording operation units is understood as recording information regarding a defect detected during only a corresponding recording operation unit. However, it is understood that other definitions for recording operations can be used.

When the recording of data is completed (i.e., additional data will not be recorded on the disc 100), the disc 100 needs to be finalized. The controller 2 controls the recording/reading unit 1 to rewrite the recorded temporary defect information and the recorded temporary defect management information, which are stored in the disc 100, as defect management information to a defect management area (DMA) of the disc 100.

FIG. 2A illustrates structures of the disc 100 of FIG. 1 according to embodiments of the present invention. (a) of FIG. 2 illustrates in detail a single record layer disc 100

having a record layer *L0*. The disc 100 includes a lead-in area, a data area, and a lead-out area. The lead-in area is located in an inner part of the disc 100 and the lead-out area is located in an outer part of the disc 100. The data area is present between the lead-in area and the lead-out area and is divided into a user data area and a spare area.

The user data area is an area where the user data is recorded. The spare area is a replacement area for a user data area having a defect and serves to compensate for the loss in the recording area due to the defect. On the assumption that defects may occur within the disc 100, it is preferable that the spare area assumes about 5% of the entire data capacity of the disc 100, so that a greater amount of data can be recorded on the disc 100. However, it is understood that other amounts can be used as the spare area.

(b) of FIG. 2 illustrates a double record layer disc 100 having two record layers *L0* and *L1*. A lead-in area, a data area, and an outer area are sequentially formed from the inner part of the first record layer *L0* to its outer part. Also, an outer area, a data area, and a lead-out area are sequentially formed from the outer part of the second record layer *L1* to the inner part. Unlike the single record layer disc 100 of FIG. 2A, the lead-out area is present in the inner part of the disc 100 of FIG. 2B. That is, the disc 100 of FIG. 2B has an opposite track path (OTP) in which data is recorded starting from the lead-in area of the first record layer *L0* toward its outer area and continuing from the outer area of the second record layer *L1* to its lead-out area. The spare area is allotted to each of the record layers *L0* and *L1*.

In this embodiment, the spare areas are present between the lead-in area and the user data area and between the user data area and the outer area. However, if necessary, a portion of the user data area may be used as another spare area. That is, more than one spare area may be present between the lead-in area and the lead-out area. However, the positions of the spare areas are not limited to this arrangement.

For disc defect management, a disc 100 according to an aspect of the present invention includes a temporary defect management area (TDMA), or includes both the TDMA and a temporary finalized DMA (TFDMA). Hereinafter, disc defect management using a TDMA, according to an embodiment of the present invention shown in FIG. 3A, and disc defect management using both the TDMA and a TFDMA, according to another embodiment of the present invention shown in FIG. 12A will be described.

FIG. 3A illustrates a data structure of the disc 100 of FIGS. 2 and 2B according to an embodiment of the present invention. Referring to FIG. 3A, if the disc 100 is a single record layer disc of FIG. 2A, a defect management area (DMA) and a temporary DMA (TDMA) are formed in a lead-in area. Alternatively, the DMA may be included in both the lead-in area and a lead-out area, or the TDMA may also be included in the lead-out area. That is, the DMA and the TDMA may be present in at least one of the lead-in area and the lead-out area. If the disc 100 is a double record layer disc shown in FIG. 2B, the DMA and the TDMA are respectively present in a lead-in area and a lead-out area located at an inner part of the disc 100. The DMA may further be included in the lead-out area and an outer area that are located at an outer part of the disc 100. Accordingly, the DMA and the TDMA are present in at least one of the lead-in area, the lead-out area, and the outer area according to an aspect of the invention.

In general, information relating to managing disc defects in the disc 100 is recorded in the DMA. Such information specifies or includes the structure of the disc 100 for disc defect management, whether the disc defect management is performed, defect information, the location of the defect information, and the position and size of a spare area. In this embodiment, because the disc 100 is a write once disc, new data is recorded after previously recorded data when the above information changes.

In general, when a disc 100 is loaded into a recording and/or reading apparatus such as that shown in FIG. 1, the apparatus reads data from a lead-in area and a

lead-out area of the disc 100 to determine how to manage the disc 100 and record data on or read data from the disc 100. However, if the amount of data recorded in the lead-in area and/or the lead-out area increases, a longer time is spent on preparing the recording or reproducing of data after the loading of the disc 100. To solve this problem, an aspect of the present invention uses temporary defect management information and temporary defect information that are to be recorded in a TDMA. The TDMA is allotted to the lead-in area and/or the lead-out area of a disc 100, and is separated from the DMA. That is, only last-recorded defect information and defect management information, which are required to perform disc defect management, are recorded in the DMA, thereby reducing the amount of information that the recording/reading unit 1 requires for a recording/reproducing operation.

In the shown embodiment, since the disc defect management is performed using the linear replacement method, the temporary defect information includes information indicating the position of an area of the disc 100 having a defect and information indicating the position of an area of the disc 100 that is replacement for the area having the defect. While not required, preferably, the temporary defect information further includes information indicating whether the defect occurs in a single defect block or physically continuous defect blocks. The temporary defect management information is used to manage the temporary defect information and includes information indicating the location of the temporary defect information recorded on the disc 100. Detailed data structures of temporary defect information and temporary defect management information will be explained later.

In the shown embodiment, the temporary defect information and temporary defect management information are recorded every time when a recording operation ends. In the TDMA, information regarding a defect occurring in data recorded during a recording operation #0 and information regarding its replacement are recorded as temporary defect information #0, and information regarding a defect occurring in data recorded during a recording operation #1 and information regarding its replacement are

recorded as temporary defect information #1. Further, management information for managing temporary defect information #0, #1 is recorded as temporary defect management information #0, #1 in the TDMA, the management information specifying the recording locations of the temporary defect information #0, #1. When additional data cannot be recorded in the data area or a user does not wish to record additional data therein (i.e., disc finalization is required), the temporary defect information and temporary defect management information recorded in the TDMA are rewritten to the DMA.

The temporary defect information and the temporary defect management information are rewritten to the DMA for the following reasons. In the case that additional data will not be recorded on the disc 100 (i.e., the disc 100 needs to be finalized), only last recorded ones of the temporary defect management information and temporary defect information, which have been updated several times, are again recorded in the DMA. Thus, the recording/reading unit 1 can quickly read defect management information from the disc 100 just by reading the last recorded defect management information, thereby enabling fast initializing of the disc 100. Further, recording of the temporary defect information and temporary defect management information in the DMA increases the reliability of information.

In this embodiment, defect information contained in previously recorded temporary defect information #0, #1, #2, and #i-1 is not included in the temporary defect information #*i*. That is, only information regarding a defect detected from a recording area during a corresponding recording operation #*i* is included in the temporary defect information #*i*. For instance, the temporary defect information #0 specifies a defect detected during a recording operation #0, and the temporary defect information #1 specifies only a defect detected during a recording operation #1. Accordingly, it is possible to effectively use a recording area of the TDMA. In other words, the recording area of the lead-in area (or the lead-out area or the outer area) including the TDMA is smaller than a data area where user data is recorded. Nevertheless, if information

regarding a defect detected whenever a recording operation is performed is recorded to include all of information regarding defects detected during previous recording operations, data may not be further recorded in the TDMA before the data area is full of data. For this reason, in this embodiment, temporary defect information includes only information regarding a defect detected during a related recording operation. Instead, during disc finalization, all defect information included in the temporary defect information #0, #1, #2, #i is read and written to the DMA.

In the case of a high-density disc with a recording capacity of several dozens of GBs, it is desirable that a cluster is allocated to an area in which temporary defect management information #i is recorded and four to eight clusters are allocated to an area in which temporary defect information #i is recorded. This is because it is preferable to record new information in units of clusters to update information when a minimum physical unit of record is a cluster, although the amount of temporary defect information #i is just several KBs. A total amount of defects allowed in a disc is preferably about 5 percent of the disc recording capacity. For instance, about four to eight clusters are required to record temporary defect information #i, considering that information regarding a defect is about 8 bytes long and the size of a cluster is 64 KBs long.

The verify-after-write method can also be performed on temporary defect information #i and temporary defect management information #i. When a defect is detected, information recorded in an area of a disc having a defect may be either recorded in a spare area using linear replacement, or recorded in an area adjacent to the TDMA using slipping replacement.

FIG. 3B illustrates a data structure of a disc with a TDMA and a DMA shown in FIG. 3A. Referring to FIG. 3B, two DMAs (i.e., DMA #1 and DMA #2) are formed to increase the robustness of defect management information and defect information. *TDMA* denotes a temporary defect management area; *Test* denotes an area in which

recording conditions of data are measured; *Drive and Disc information* is an area in which information regarding a drive used during a recording and/or reproducing operation(s) and disc information are recorded; and *Buffer 1*, *Buffer 2*, and *Buffer 3* are buffers indicating borders of the respective areas.

FIGS. 4A and 4B illustrates a data structure of temporary management information TDMA according to an embodiment of the present invention.

FIG. 4A illustrates a data structure of the temporary defect management area.

Referring to FIG. 4A, corresponding temporary defect information and temporary defect management information are recorded as a pair of information in the TDMA. More specifically, temporary management information *TDMA #0, TDMA #1* are sequentially recorded starting from the start of the TDMA. A pair of corresponding temporary defect management *TDDS #0* and temporary defect information *TDFL #0* are included twice in the temporary management information *TDMA #0*. A pair of corresponding temporary defect management information *TDDS #1* and temporary defect information *TDFL #1* are included twice in temporary management information *TDMA #1*. A reason for recording the same information twice is to increase the reliability and robustness of the information. The temporary defect management information *TDDS #0, #1*, specifies the locations of the corresponding temporary defect information *TDFL #0, #1*, respectively. Each temporary defect management information further specifies the location of temporary defect information recorded right before its corresponding temporary defect information. For instance, the temporary management information *TDMA #1* sequentially includes a pair of the temporary defect information *TDFL #1* and temporary defect management information *TDDS #1*, and a copy of the temporary defect information *TDFL #1* and temporary defect management information *TDDS #1*. The temporary defect management information *TDDS #1* contains location information regarding the temporary defect information *TDFL #1* and a copy of temporary defect information *TDFL #0* recorded right before the temporary

defect information *TDFL #1*. The copy of the temporary defect management information *TDDS #1* contains location information regarding its corresponding copy of the temporary defect information *TDFL #1*, and location information regarding the temporary defect information *TDFL #1*. As described above, if temporary defect management information further specifies the location of temporary defect information recorded right before corresponding temporary defect information, it is possible to more rapidly read all recorded temporary defect information than where temporary defect information is accumulatively recorded. The number of recording the temporary defect management information *TDDS #0, #1* and the temporary defect information *TDFL #0, #1* is not limited.

FIG. 4B illustrates a data structure of a TDMA according to another embodiment of the present invention.

Referring to FIG. 4B, compared to the TDMA of FIG. 4A, corresponding temporary defect information and temporary defect management information are recorded as a pair of information in the TDMA of FIG. 4B, but the sequence of recording the information is not the same. More specifically, temporary management information *TDMA #0, #1* is sequentially recorded starting from the end of the TDMA. A pair of corresponding temporary defect management *TDDS #0* and temporary defect information *TDFL #0* are included twice in the temporary management information *TDMA #0*. A pair of corresponding temporary defect management information *TDDS #1* and temporary defect information *TDFL #1* are included twice in temporary management information *TDMA #1*, thereby increasing the reliability and robustness of the information. The temporary defect management information *TDDS #0, #1* specifies the locations of their corresponding temporary defect information *TDFL #0, #1* respectively. Each temporary defect management information further specifies the location of the temporary defect information recorded right before its corresponding temporary defect information. For instance, the temporary management information *TDMA #1* sequentially includes a pair of the temporary defect information *TDFL #1* and

the temporary defect management information *TDDS #1*, and a copy of the temporary defect information *TDFL #1* and the temporary defect management information *TDDS #1*. Also, the temporary defect management information *TDDS #1* contains location information regarding the temporary defect information *TDFL #1* and a copy of the temporary defect information *TDFL #0* recorded right before the temporary defect information *TDFL #1*. The copy of the temporary defect management information *TDDS #1* contains location information regarding its corresponding copy of the temporary defect information *TDFL #1*, and the location information regarding temporary defect management information *TDFL #1*. As such, by notifying the location information of temporary defect information just recorded, it is possible to more rapidly access temporary defect information recorded until now, when all of the temporary defect information has to be simultaneously read.

FIG. 5A illustrates a data structure of temporary defect management information *TDDS #i*.

Referring to FIG. 5A, the temporary defect management information *TDDS #i* includes an identifier for the temporary defect management information *TDDS #i*, a pointer to the recording position of a copy of temporary defect information *TDFL #i-1* recorded right before corresponding temporary defect information *TDFL #i*, and a pointer to the recording position of the temporary defect information *TDFL #i*.

FIG. 5B illustrates a data structure of a copy of temporary defect management information *TDDS #i*.

Referring to FIG. 5B, the copy of temporary defect management information *TDDS #i* contains an identifier for the copy of the temporary defect management information *TDDS #i*, a pointer to the recording position of the temporary defect information *TDFL #i* recorded in the temporary defect management information *TDDS #i*, and a pointer to the recording position of a copy of the temporary defect information *TDFL #i*.

FIG. 6 illustrates a data structure of temporary defect information *TDFL #i*. Referring to FIG. 6, temporary defect information *TDFL #i* contains an identifier for the temporary defect information *TDFL #i*, and information regarding a defect detected during a corresponding recording operation #i. That is, information regarding defects detected during previous recording operations #0, #1, #i-1 is not included in the temporary defect information *TDFL #i*. Here, the information regarding a defect indicates the positions of the defect and its replacement and whether the defect occurs in a single defect block or continuous defect blocks. The information regarding the defect will be described later.

FIG. 7 is a reference diagram illustrating in detail recording of data in a user data area *A* and a spare area *B*, according to an embodiment of the present invention. Data can be processed in units of sectors or clusters according to an aspect of the invention. A sector denotes a minimum unit of data that can be managed in a file system of a computer or in an application. A cluster denotes a minimum unit of data that can be physically recorded on a disc at once. In general, one or more sectors constitute a cluster.

There are two types of sectors: a physical sector and a logical sector. The physical sector is an area on a disc where a sector of data is to be recorded. An address for detecting the physical sector is called a physical sector number (PSN). The logical sector is a unit in which data can be managed in a file system or an application. An address for detecting the logical sector is called a logical sector number (LSN). A disc recording/reading apparatus such as that shown in FIG. 1 detects the recording position of data on a disc 100 using a PSN. In a computer or an application relating to the data, all of the data is managed in units of LSNs and the position of data is detected using an LSN. LSNs and PSNs are mapped by a controller 2 of the recording/reading apparatus, based on whether the disc 100 contains a defect and an initial recording position of data.

Referring to FIG. 7, the user data area A and the spare area B includes PSNs that are sequentially allocated to a plurality of sectors (not shown). In general, each LSN corresponds to at least one PSN. However, since LSNs are allocated to non-defective areas, including replacement areas recorded in the spare area B, the correspondence between the PSNs and the LSNs is not maintained when a disc 100 has a defective area, even if the size of a physical sector is the same as a size of a logical sector.

In the user data area *A*, the user data is recorded either in a continuous recording mode or a random recording mode. In the continuous recording mode, the user data is recorded sequentially and continuously. In the random recording mode, the user data is randomly recorded. In the user data area *A*, sections 1001 through 1007 denote predetermined units of data in which the verify-after-write method is performed. A recording apparatus records user data in section 1001, returns to the start of section 1001, and checks if the user data is appropriately recorded or a defect exists in section 1001. If a defect is detected in a portion of section 1001, the portion is designated as defect #1. The user data recorded in defect #1 is also recorded on a portion of the spare area *B*. Here, the portion of the spare area *B* in which data recorded in defect #1 is rewritten is called replacement #1. Next, the recording apparatus records user data in section 1002, returns to the start of section 1002, and checks whether the data is properly recorded or a defect exists in section 1002. If a defect is detected in a portion of section 1002, the portion is designated as defect #2. Likewise, replacement #2 corresponding to defect #2 is formed in the spare area *B*. Further, defect #3 and replacement #3 are designated in section 1003 of the user data area *A* and the spare area *B*, respectively. In section 1004, a defect does not occur and a defective area is not designated.

The recording apparatus records information regarding defect #1, #2, and #3 occurring in sections 1001 through 1004 as temporary defect information *TDFL #0* in a TDMA, when recording operation #0 is expected to end, after the recording and

verifying of data to section 1004 (i.e., when a user presses the eject button of a recording apparatus or recording of user data allocated in a recording operation is complete). Also, management information for managing temporary defect information *TDFL #0* is recorded as temporary defect management information *TDDS #0* in the TDMA.

When recording operation #1 starts, data is recorded in sections 1005 through 1007 and defects #4 and #5 and replacements #4 and #5 are formed in the user data area *A* and the spare area *B*, respectively, as explained for sections 1001 through 1004. If the second recording operation is expected to end, the recording apparatus records information regarding defects #4 and #5 as temporary defect information *TDFL #1*, and records the information contained in the defect information *TDFL #1* once again. Thereafter, temporary management information for managing the temporary defect information *TDFL #1* is recorded as temporary defect management information *TDDS* #1 in the TDMA.

FIG. 8 illustrates data structures of the temporary defect information *TDFL #0* and *#1* recorded as explained with respect to FIG. 7.

Referring to FIG. 8, the temporary defect information *TDFL #0* describes defects detected during a recording operation #0. That is, the temporary defect information *TDFL #0* contains information regarding defects #1, #2, and #3. The information regarding defect #1 indicates the position of an area in which defect #1 exists and the position of an area in which replacement #1 is recorded. The information regarding defect #2 indicates the position of an area in which defect #2 exists, and the position of an area in which replacement #2 is recorded. The information regarding defect #3 the position of an area in which defect #3 exists, and the position of an area in which replacement #3 is recorded.

Temporary defect information *TDFL #1* describes only defects detected during a recording operation #1. That is, the temporary defect information *TDFL #1* contains information regarding defects #4 and #5.

Temporary defect information according to an aspect of the present invention describes only defects detected during a corresponding recording operation. For disc finalization, all of temporary defect information recorded in a TDMA must be read and written to a DMA. For this reason, as previously mentioned with reference to FIGs. 4A, 4B, and 5, temporary defect management information contains both information regarding the location of corresponding temporary defect information and information regarding the location of temporary defect information recorded right before the corresponding temporary defect information. Accordingly, it is possible to more rapidly read all recorded temporary defect information than where all recorded temporary defect information is accumulatively recorded.

FIG. 9 illustrates a data structure of information regarding a defect #i according to an embodiment of the present invention. Referring to FIG. 9, the information regarding a defect #i describes a pointer to the defect #i and a pointer to a corresponding replacement #i. Further, while not required in all aspects, the information regarding the defect #i may further include state information that indicates whether the defect #i occurs in continuous defect blocks or a single defect block. The inclusion of the state information into the information regarding the defect #i is optional. If the defect #i occurs in the continuous defect blocks, the state information further represents whether the pointer for defect #i points to the start or end of the continuous defect blocks and whether the pointer for replacement #i points to the start or end of a replacement block that replaces defect #i. When the state information indicates the pointer for defect #i as the start of the continuous defect blocks and the pointer for replacement #i as the start of the replacement block, the pointer for defect #i represents a starting physical sector number of the continuous defect blocks and the pointer for replacement #i represents a starting physical sector number of replacement #i. In

contrast, when the state information indicates the pointer for defect #i as the end of the continuous defect blocks and the pointer for replacement #i as the end of the replacement block, the pointer for defect #i represents an ending physical sector number of the continuous defect blocks and the pointer for replacement #i represents an ending physical sector number of replacement #i. The definition of at least two continuous defect blocks where defects exist using state information enables effectively recording of information and saves a space of recording, even if information regarding defects is not recorded in units of blocks. Here, the block denotes a logical record unit of data.

The pointer for defect #i specifies a starting and/or ending point(s) of defect #i. The pointer for defect #i may include a starting PSN of defect #i. The pointer for replacement #i specifies a starting and/or ending points of replacement #i. The pointer for replacement #i may also include a starting PSN of replacement #i.

Hereinafter, embodiments of a disc defect management method according to an aspect of the present invention using the recording unit 1 of FIG. 1 and the disc 100 according to the embodiment of the present invention shown in FIG. 3A, will be described with reference to the accompanying drawings.

FIG. 10 is a flowchart illustrating a disc defect management method according to an embodiment of the present invention.

Referring to FIG. 10, the recording apparatus of FIG. 1 records information regarding data, which is recorded according to a first recording operation, as first temporary defect information in a TDMA of a disc 100 (action 1001). This process serves to manage disc defects. The recording apparatus records temporary management information for managing the first temporary defect information as first temporary defect management information in the TDMA (action 1002). It is checked whether finalizing of the disc 100 is required (action 1003). If it is determined in action 1003 that the finalizing of the disc 100 is not required, actions 1001 and 1002 are

repeated while increasing indexes given to each recording operation, temporary defect information, and temporary defect management information by 1 (action 1004). However, if it is determined in action 1003 that disc finalization is required, all of recorded temporary defect management information and temporary defect information are read and recorded in a DMA (action 1005). That is, all of the recorded temporary defect management information and temporary defect information are recorded as the final defect management information and final defect information in the DMA, respectively. The final defect information and final defect management information may be repeatedly recorded to increase the reliability of data detection. Further, the verify-after-write method may be performed on the final defect management information and final defect information. If a defect is detected from this information, an area of the disc 100 having the defect and the following area containing data may be regarded as being unavailable (i.e., the area is designated as a defective area), and the final defect management information and final defect information may be again recorded after the defective area.

FIG. 11 is a flowchart illustrating a disc defect management method according to an embodiment of the present invention.

Referring to FIG. 11, the recording apparatus of FIG. 1 records user data in a data area of a disc 100 in units of data to facilitate the verify-after-write method (action 1101). The data recorded in action 1101 is verified to detect an area of the disc 100 having a defect (action 1102). The controller 2 of FIG. 1 designates the area having the defect as a defective area, controls the recording/reading unit 1 to rewrite data recorded in the defective area to a spare area so as to create a replacement area, and creates pointer information specifying the positions of the defective area and the replacement area (action 1103). The pointer information is recorded as first temporary defect information in the memory 3 of FIG. 1 (action 1104). The first temporary defect information may further include state information describing whether the defect occurs in a single defect block or continuous defect blocks. It is checked whether a current recording operation

is expected to end (action 1105). If it is determined in action 1105 that the recording operation is not expected to end, actions 1101 through 1104 are repeated until the recording operation ends.

If it is determined in action 1105 that the recording operation is likely to end (i.e., when the recording of the user data is completed according to a user input or according to the first recording operation), the controller 2 controls the recording/reading unit 1 to read the first temporary defect information from the memory 3 and record the first temporary defect information as first temporary defect information *TDFL #0* in a TDMA (action 1106). Management information for managing the first temporary defect information *TDFL #0* is recorded as first temporary defect management information *TDDS #0* twice in the TDMA, the first temporary defect management information *TDDS #0* recorded right after the first temporary defect information *TDFL #0* (action 1107). It is understood that the number of times of recording temporary defect management information and temporary defect information are not limited. It is checked whether disc finalization is required (action 1108). If it is determined in action 1108 that disc finalization is not required, actions 1101 through 1107 are repeated. Whenever actions 1101 through 1107 are repeated, indexes given to a recording operation, temporary defect information, and temporary defect management information are increased by 1 (action 1109). However, temporary defect information *TDFL #1* specifies only information regarding a defect detected during a recording operation #1. That is, temporary defect information *TDFL #1* does not contain information regarding defects detected during the previous recording operation #0. Further, the temporary defect management information *TDDS #1* describes the location of corresponding temporary defect information *TDFL #1* and the location of temporary defect information *TDFL #0* recorded right before the temporary defect information *TDFL #1*.

If it is determined in action 1108 that disc finalization is needed, all of recorded temporary defect information *TDFL #0, #1, #i-1, #i* and temporary defect management information *TDDS #0, #1, ..., #i-1, #i* are recorded as the final defect information *DFL*

and the final defect management information *DDS* in the DMA, respectively (action 1110). The final defect information *DFL* and the final defect management information *DDS* may be repeatedly recorded several times to increase the reliability of data detection. Similarly, the verify-after-write method may be performed on the final defect information and defect management information. If a defect is detected in this information, an area of the disc having the defect and the following area containing data may be regarded as being unavailable (i.e., the area is designated as a defective area), and the final defect management information and defect information may be again recorded after the defective area.

[Effect of the Invention]

As described above, an aspect of the present invention provides a disc defect management method that is applicable to write once discs. By forming a temporary defect information area in a lead-in area and/or a lead-out area to record information regarding disc defects in correspondence to a recording operation, reading all information regarding disc defects recorded in the temporary defect information area when finalizing, and at once recording the information regarding disc defects in a defect management area, the defect management area can be efficiently used. In particular, the location information of corresponding temporary defect information and the location information of temporary defect information recorded right before the corresponding temporary defect information are recorded in the temporary defect management information, thereby making the recorded temporary defect information to be more rapidly read when all the recorded temporary defect information has to be read.

In particular, by recording information regarding disc defects in units of a recording operation in the temporary defect information area, the amount of a required recording area is reduced compared to a method of accumulatively recording information regarding disc defects for each recording operation. Accordingly, it is

possible to stably perform defect management for data areas without allocating a large amount of space for the temporary defect information area.

5

What is claimed is:

1. A write once disc with at least one record layer on which a lead-in area, a data area, and a lead-out area are sequentially arranged, the write once disc comprising:

a defect management area formed on at least one of the lead-in area and the lead-out area; a temporary defect management area formed on at least one of the lead-in area and the lead-out area,

wherein the temporary defect management area is an area in which temporary defect information indicating only information regarding defects generated during the corresponding recording operation, and temporary defect management information indicating information for managing the temporary defect information are recorded, and

the defect management area is an area in which the temporary defect information and the temporary defect management information are respectively recorded as defect information and defect management information when finalizing.

2. A write once disc with a first record layer on which a lead-in area, a data area, and a lead-out area are sequentially arranged, and a second record layer on which an outer area, a data area, and a lead-out area are sequentially arranged, the write once disc comprising:

a defect management area formed on at least one of the lead-in area, the lead-out area, and the outer area; and

a temporary defect management area formed on at least one of the lead-in area, the lead-out area, and the outer area,

wherein the temporary defect management area is an area in which temporary management information indicating only information regarding defects generated during the corresponding recording operation is recorded, and temporary defect management information including information for managing the temporary defect information are recorded, and

the defect management area is an area in which the temporary management

information and temporary defect management information recorded in the temporary defect management area when finalizing are respectively recorded as defect information and defect management information.

3. The write once disc of claim 1 or 2, wherein a plurality of areas exist in the same defect management area.

4. The write once disc of claim 1 or 2, wherein the temporary defect information and the temporary defect management information are recorded several times as pairs of information to be adjacent to each other in the temporary defect management area.

5. The write once disc of claim 4, wherein the temporary defect information and the temporary defect management information are recorded several times, and the temporary defect management information comprises information indicating a location in which the corresponding temporary defect information is recorded.

6. The write once disc of claim 4, wherein the temporary defect management information comprises information indicating a location of the previously recorded temporary defect information.

7. The write once disc of claim 1 or 2, wherein the temporary defect information comprises a pointer pointing out to a location of a defect, and a pointer pointing out to a location of a replacement for the defect.

8. The write once disc of claim 7, wherein the temporary defect information further comprises state information representing whether the defect is a single defect block or successive defective blocks

9. The write once disc of claim 8, wherein the state information is information indicating that the defect is the successive defect blocks, and a pointer pointing out to a location corresponding to the defect, and a pointer pointing out to a location of a replacement for the location respectively indicate a start location of the defect and a start location of the replacement.

10. The write once disc of claim 8, wherein the state information is information indicating that the defect is the successive defect blocks, and a pointer pointing out to a location corresponding to the defect, and a pointer pointing out to a location of a replacement for the location respectively indicate an end location of the defect and an end location of the replacement.

11. A method of managing disc defects, the method comprising:

(a) recording only information regarding a defect detected in data, which is recorded in a data area of a disc during a first recording operation, as first temporary defect information in a temporary defect management area;

(b) recording management information for managing the first temporary defect information as first temporary defect management information in the temporary defect management area;

(c) repeating (a) and (b) at least once while increasing indexes given to the recording operation, the temporary defect information, and the temporary management information by 1;

(d) reading and writing all of recorded temporary defect management information and temporary defect information in a defect management area which is formed on at least one of the lead-in area, the lead-out area, and the outer area of the disc.

12. The method of claim 11, wherein operation (d) is performed after data according to a final operation is recorded in the data area.

13. The method of claim 11, wherein operations (a) and (b) comprises sequentially recording the temporary defect information and the temporary defect management information as pairs of information to be adjacent to each other, several times, starting from the start of the temporary defect information area.

14. The method of claim 13, wherein operations (a) and (b) comprises repeatedly recording the temporary defect information and the temporary defect management information, several times.

15. The method of claim 13, wherein operation (b) comprises recording location information of corresponding temporary defect information, and location information temporary defect information recorded right before the corresponding temporary defect information, as the temporary defect management information.

16. The method of claim 11 or 12, wherein operations (a) and (b) comprises sequentially recording the temporary defect information and the temporary defect management information as pairs of information to be adjacent to each other, several times, starting from the end of the temporary defect information area.

17. The method of claim 16, wherein operations (a) and (b) comprises repeatedly recording the temporary defect information and the temporary defect management information, several times.

18. The method of claim 16, wherein operation (b) comprises recording location information of corresponding temporary defect information, and location information temporary defect information recorded right before the corresponding temporary defect information, as the temporary defect management information.

19. The method of claim 11 or 12, wherein operation (a) comprises:

(a1) recording data in a predetermined unit of data;

(a2) verifying the recorded data to detect a part in which a defect is found;

(a3) storing defective area information indicating the part in which the defect is found, and information indicating a substitution area for substituting for the part in which the defect is found, as temporary defect information, in a memory;

(a4) repeating operation (a1) through (a3) at least one time;

(a5) if the recording operation is terminated, reading the information stored in the memory and recording the read information as temporary defect information in the temporary defect management area; and

20. A recording apparatus comprising:

a recording/reading unit that records data on or reads data from a disc; and

a controller that controls the recording/reading unit to record information regarding a defect detected from data, which is recorded in a data area of the disc according to a recording operation, as first temporary defect information in a temporary defect management area which is formed on at least one of a lead-in area and a lead-out area of the disc, and to record management information for managing the temporary defect information, as temporary defect management information, in the temporary defect management area.

21. The recording apparatus of claim 20, wherein the controller controls the recording/reading unit in such a manner that the corresponding temporary defect information and temporary defect management information are recorded as pairs of information to be adjacent to each other.

22. The recording apparatus of claim 22, wherein the controller controls the recording/reading unit to read temporary defect information and temporary defect management information recorded in units of a recording operation when finalizing, and record the temporary defect information and temporary defect management information

in a defect management area which is formed in at least one of the lead-in area and the lead-out area of the disc.

23. A recording apparatus comprising a recording/reading unit that records data on or reads data from a disc; and

a controller that controls the recording/reading unit to record information regarding a defect detected from data, which is recorded in a data area of the disc according to a recording operation, as first temporary defect information in a temporary defect management area which is formed in at least one of a lead-in area and a lead-out area of the disc, to record defect management information for managing the first temporary defect information, as first temporary defect management information, in the temporary defect management area, to record data in the data area while increasing indexes allotted to the recording operation, the temporary defect information, and the temporary defect management information by 1, and to read and record the recorded temporary defect management information and the temporary defect information in a defect management area, when finalizing.

24. The recording apparatus of claim 23, wherein the controller controls the recording/reading unit to record data according to a final recording operation in the data area, and to read the recorded temporary defect information and temporary defect management information, as final defect management information and final defect information, in the defect management area which is formed in at least one of the lead-in area, the lead-out area, and the outer area of the disc.

25. The recording apparatus of claim 23, wherein the controller controls the recording/reading unit in such a manner that corresponding temporary defect information and temporary defect management information are sequentially recorded as pairs of information, in the temporary defect management area, starting from the start of the temporary defect management area.

26. The recording apparatus of claim 23, wherein the controller controls the recording/reading unit in such a manner that corresponding temporary defect information and temporary defect management information are sequentially recorded as pairs of information, in the temporary defect management area, starting from the end of the temporary defect management area.

27. The recording apparatus of claim 25 and 26, wherein the controller controls the recording/reading unit to record the location information of corresponding temporary defect information, and the location information of temporary defect information recorded right before the corresponding temporary defect information, as the temporary defect management information.

28. The recording apparatus of claim 23, further comprising a memory, wherein the controller controls the recording/reading unit to record data according to a predetermined recording operation in predetermined units, to verify the recorded data to detect a defective area in which a detect is generated, to generate information indicating the defective area and information indicating a replacement for the defective area, to store the information as temporary defect information in the memory, to record the data according to the recording operation in predetermined units from after the defective area, to record all the data according to the recording operation and read the temporary defect information stored in the memory, and to record the temporary defect information in the temporary defect management area.

FIG. 1

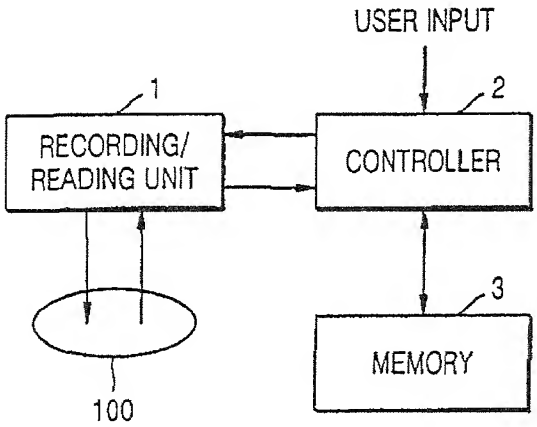
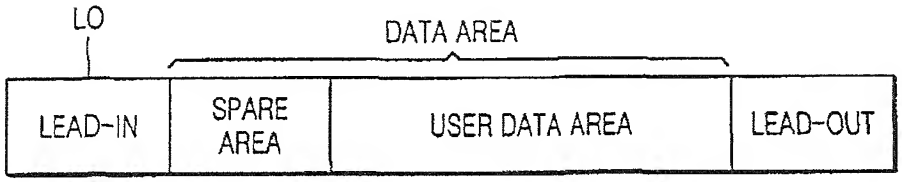
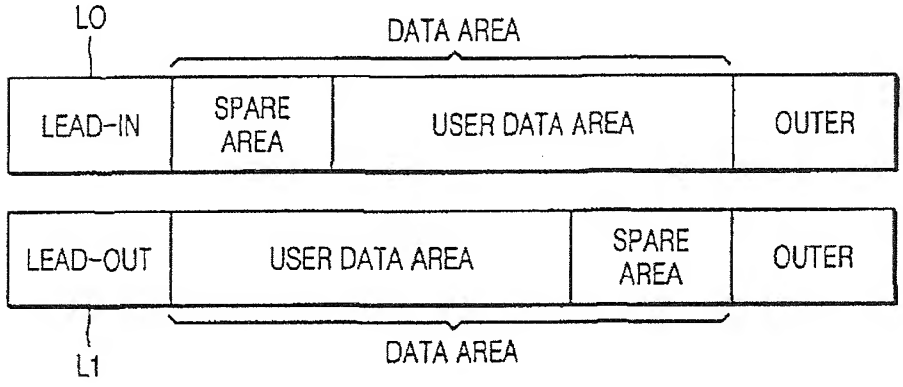

USER INPUT
1
2
RECORDING/
READING UNIT
CONTROLLER
3
MEMORY
100

FIG. 2


LO
DATA AREA
LEAD-IN
SPARE AREA
USER DATA AREA
LEAD-OUT

(a)


LO
DATA AREA
LEAD-IN
SPARE AREA
USER DATA AREA
OUTER
LEAD-OUT
USER DATA AREA
SPARE AREA
OUTER
L1
DATA AREA

(b)

FIG. 3A

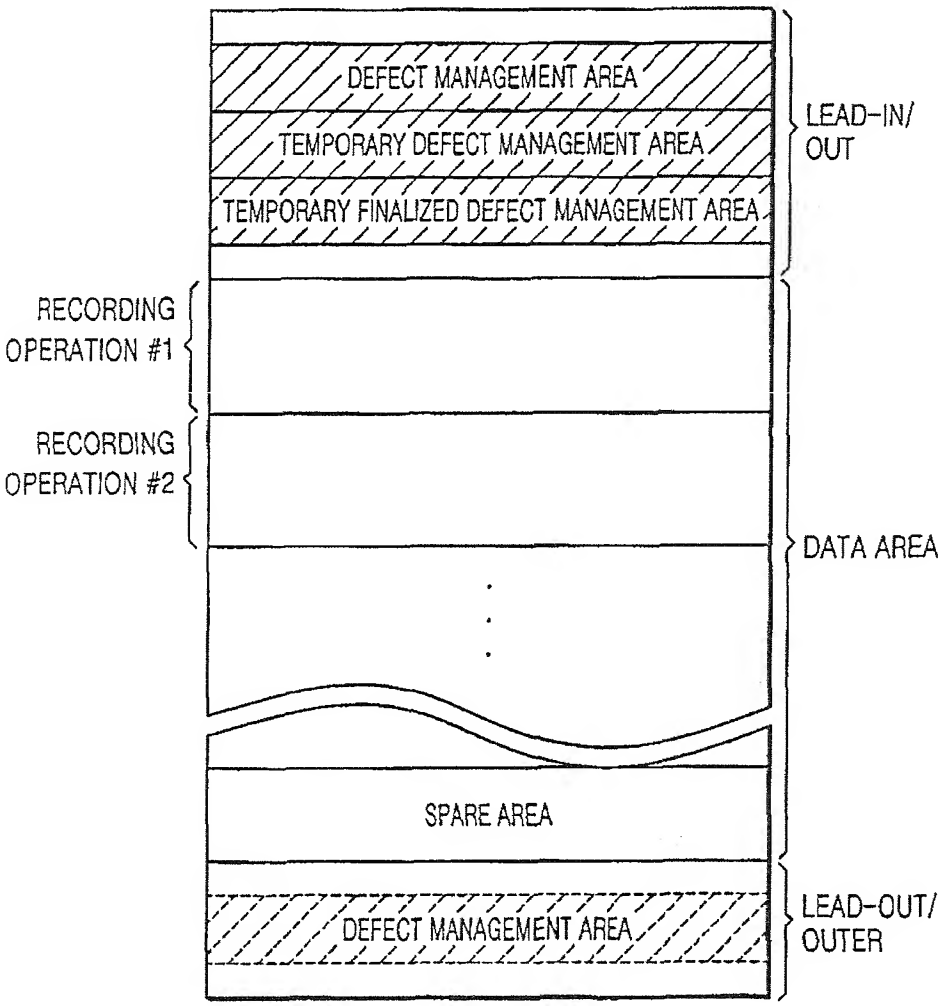

DEFECT MANAGEMENT AREA
TEMPORARY DEFECT MANAGEMENT AREA
TEMPORARY FINALIZED DEFECT MANAGEMENT AREA
LEAD-IN/ OUT
RECORDING OPERATION #1
RECORDING OPERATION #2
DATA AREA
SPARE AREA
DEFECT MANAGEMENT AREA
LEAD-OUT/ OUTER

FIG. 3B

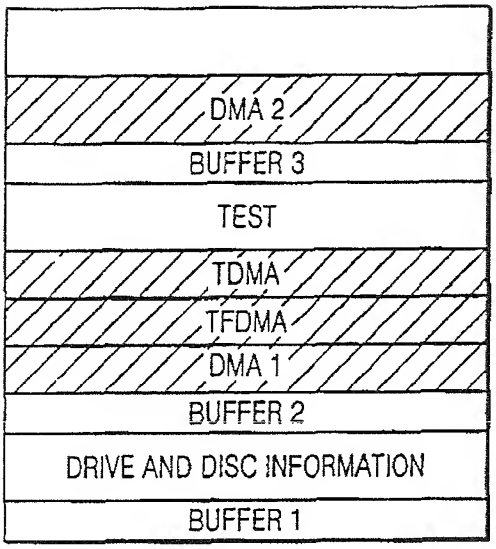

DMA 2
BUFFER 3
TEST
TDMA
TFDMA
DMA 1
BUFFER 2
DRIVE AND DISC INFORMATION
BUFFER 1

FIG. 4A

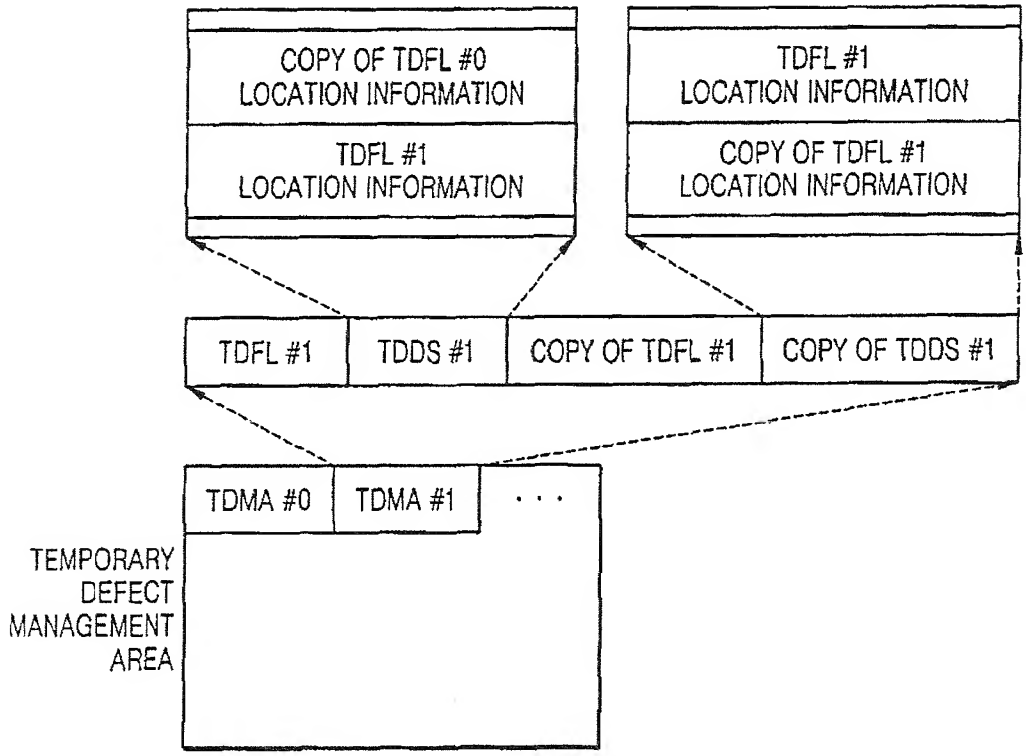

COPY OF TDFL #0
LOCATION INFORMATION
TDFL #1
LOCATION INFORMATION
TDFL #1
LOCATION INFORMATION
COPY OF TDFL #1
LOCATION INFORMATION
TDFL #1
TDDS #1
COPY OF TDFL #1
COPY OF TDDS #1
TDMA #0
TDMA #1
. . .
TEMPORARY
DEFECT
MANAGEMENT
AREA

FIG. 4B

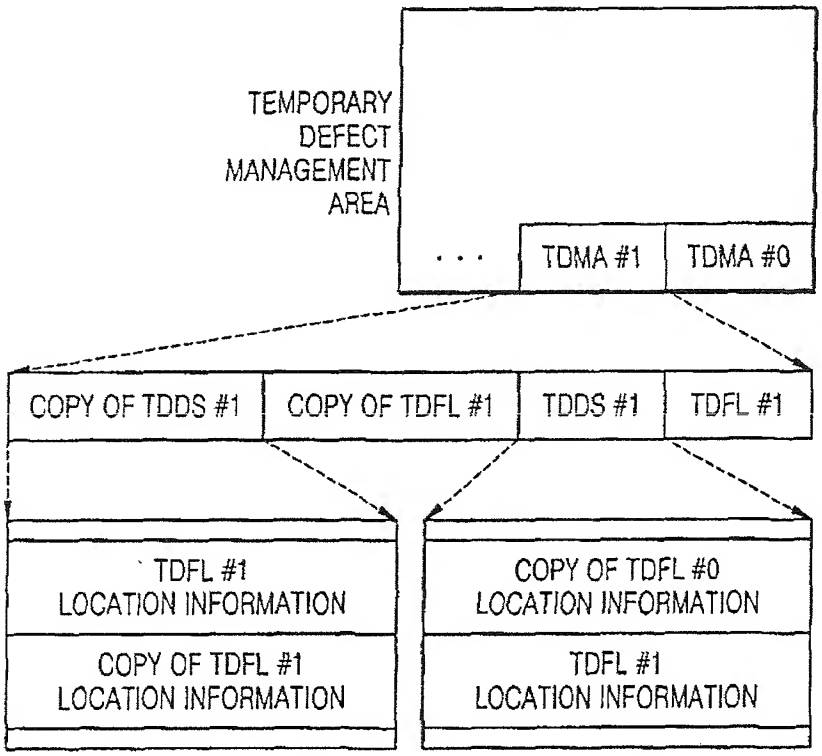

TEMPORARY DEFECT MANAGEMENT AREA
. . .
TDMA #1
TDMA #0
COPY OF TDDS #1
COPY OF TDFL #1
TDDS #1
TDFL #1
TDFL #1 LOCATION INFORMATION
COPY OF TDFL #1 LOCATION INFORMATION
COPY OF TDFL #0 LOCATION INFORMATION
TDFL #1 LOCATION INFORMATION

FIG. 5A

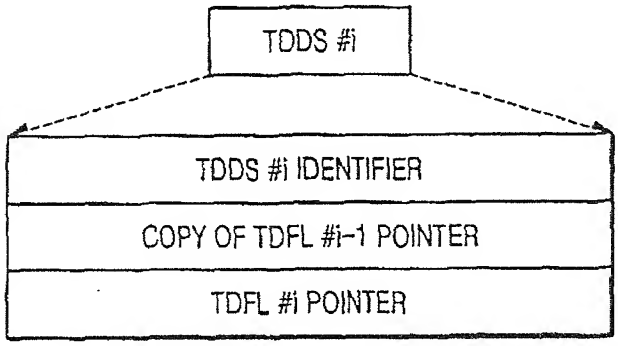

TDDS #i
TDDS #i IDENTIFIER
COPY OF TDFL #i-1 POINTER
TDFL #i POINTER

FIG. 5B

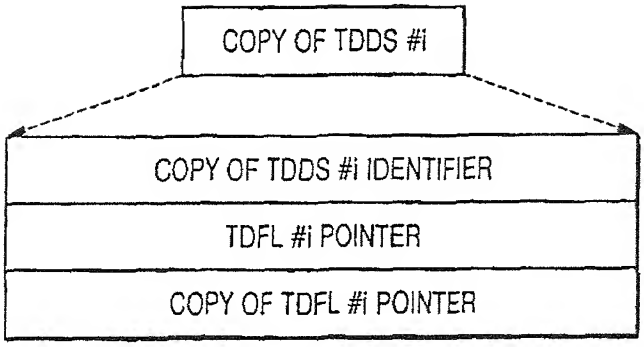

COPY OF TDDS #i
COPY OF TDDS #i IDENTIFIER
TDFL #i POINTER
COPY OF TDFL #i POINTER

FIG. 6

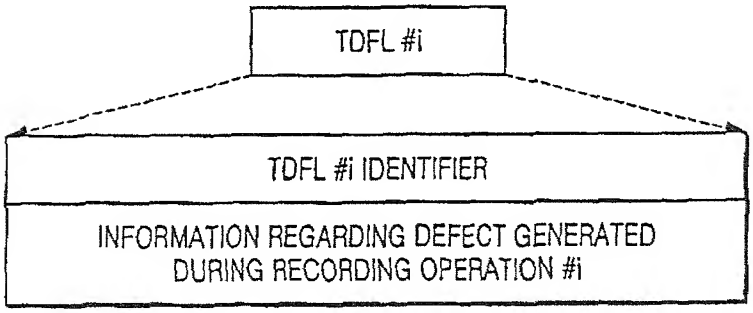

TDFL #i
TDFL #i IDENTIFIER
INFORMATION REGARDING DEFECT GENERATED DURING RECORDING OPERATION #i

FIG. 7

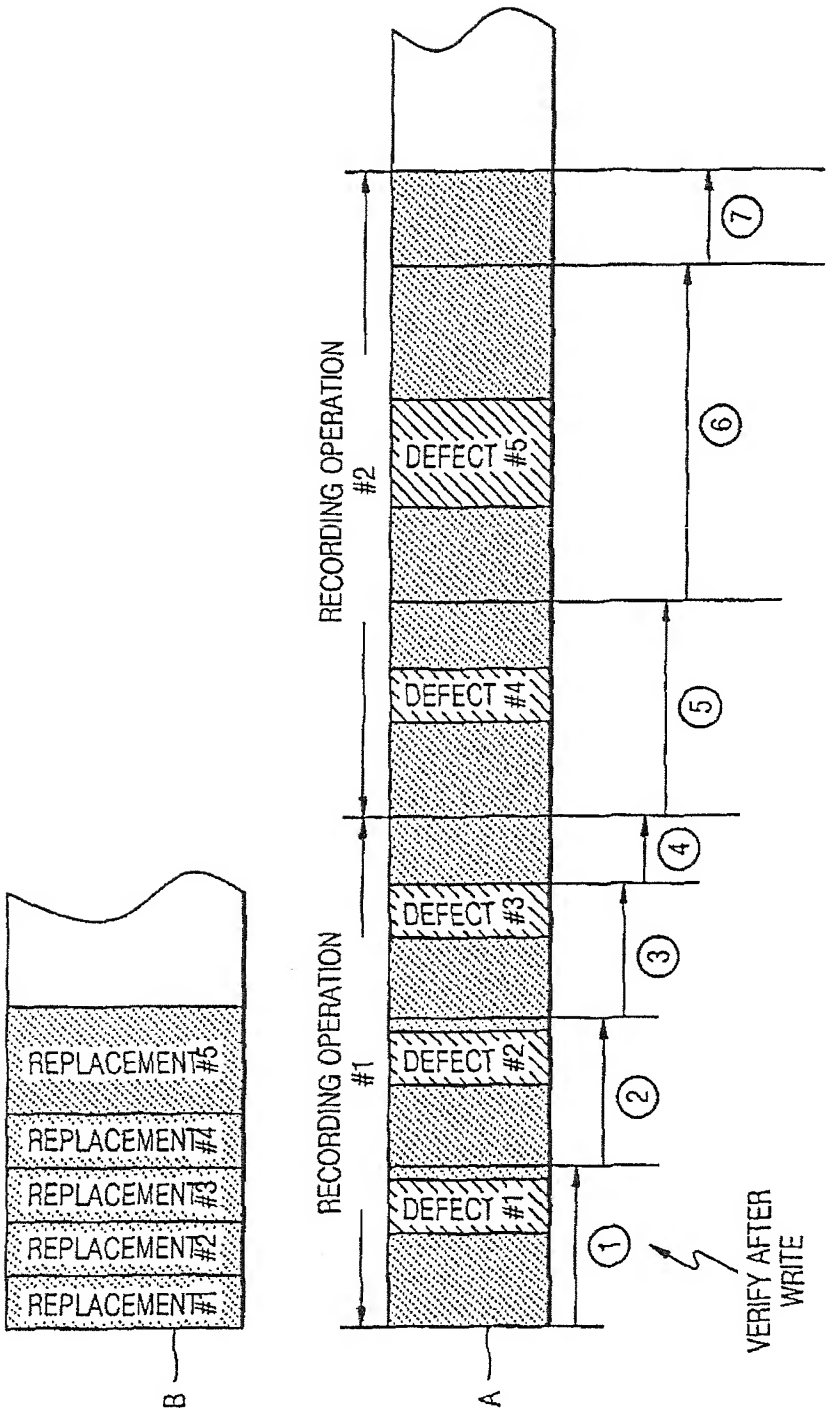
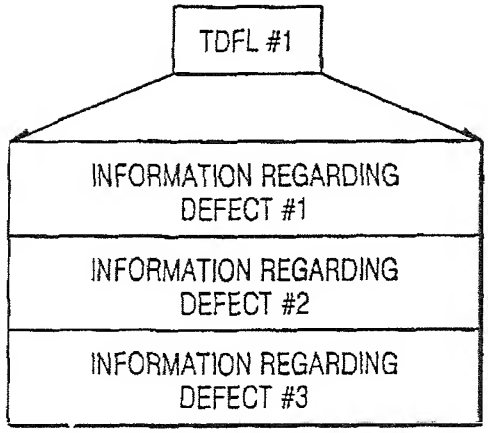
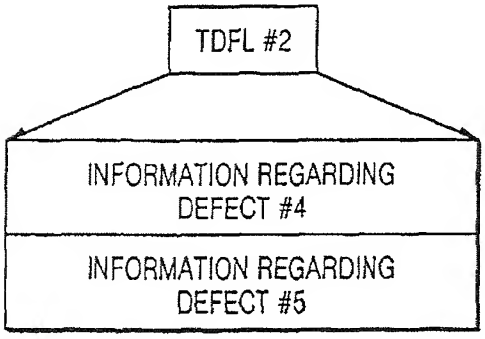

REPLACEMENT #5
REPLACEMENT #4
REPLACEMENT #3
REPLACEMENT #2
REPLACEMENT #1
B
RECORDING OPERATION #1
RECORDING OPERATION #2
DEFECT #1
DEFECT #2
DEFECT #3
DEFECT #4
DEFECT #5
A
1
2
3
4
5
6
7
VERIFY AFTER WRITE

FIG. 8


TDFL #1
INFORMATION REGARDING DEFECT #1
INFORMATION REGARDING DEFECT #2
INFORMATION REGARDING DEFECT #3

(a)


TDFL #2
INFORMATION REGARDING DEFECT #4
INFORMATION REGARDING DEFECT #5

(b)

FIG. 9

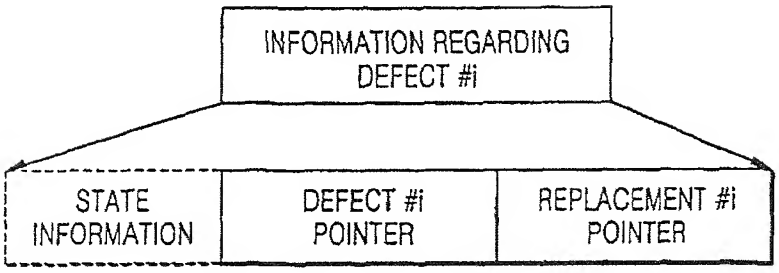

INFORMATION REGARDING DEFECT #i
STATE INFORMATION
DEFECT #i POINTER
REPLACEMENT #i POINTER

FIG. 10

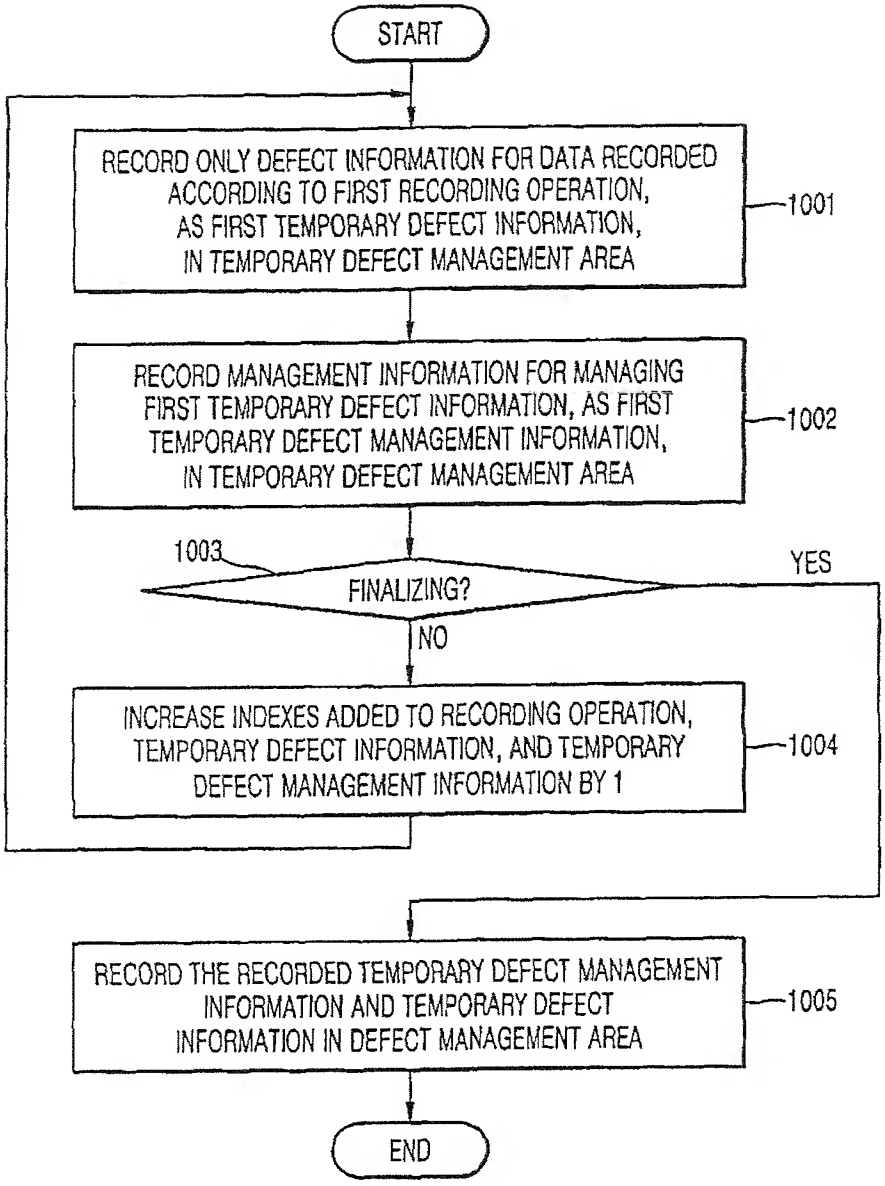
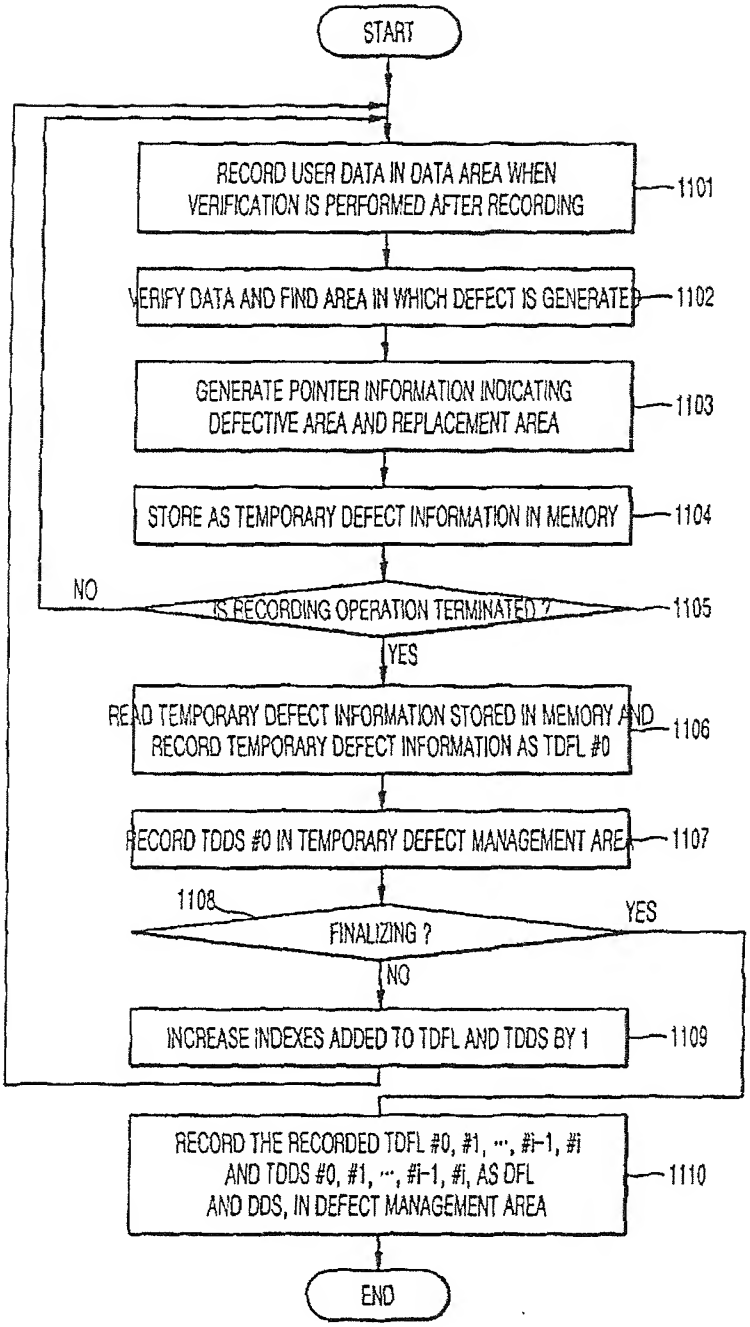

START
RECORD ONLY DEFECT INFORMATION FOR DATA RECORDED ACCORDING TO FIRST RECORDING OPERATION, AS FIRST TEMPORARY DEFECT INFORMATION, IN TEMPORARY DEFECT MANAGEMENT AREA
1001
RECORD MANAGEMENT INFORMATION FOR MANAGING FIRST TEMPORARY DEFECT INFORMATION, AS FIRST TEMPORARY DEFECT MANAGEMENT INFORMATION, IN TEMPORARY DEFECT MANAGEMENT AREA
1002
1003
FINALIZING?
YES
NO
INCREASE INDEXES ADDED TO RECORDING OPERATION, TEMPORARY DEFECT INFORMATION, AND TEMPORARY DEFECT MANAGEMENT INFORMATION BY 1
1004
RECORD THE RECORDED TEMPORARY DEFECT MANAGEMENT INFORMATION AND TEMPORARY DEFECT INFORMATION IN DEFECT MANAGEMENT AREA
1005
END

FIG. 11


START
RECORD USER DATA IN DATA AREA WHEN VERIFICATION IS PERFORMED AFTER RECORDING
1101
VERIFY DATA AND FIND AREA IN WHICH DEFECT IS GENERATED
1102
GENERATE POINTER INFORMATION INDICATING DEFECTIVE AREA AND REPLACEMENT AREA
1103
STORE AS TEMPORARY DEFECT INFORMATION IN MEMORY
1104
NO
IS RECORDING OPERATION TERMINATED ?
1105
YES
READ TEMPORARY DEFECT INFORMATION STORED IN MEMORY AND RECORD TEMPORARY DEFECT INFORMATION AS TDFL #0
1106
RECORD TDDS #0 IN TEMPORARY DEFECT MANAGEMENT AREA
1107
1108
FINALIZING ?
YES
NO
INCREASE INDEXES ADDED TO TDFL AND TDDS BY 1
1109
RECORD THE RECORDED TDFL #0, #1, ···, #i-1, #i AND TDDS #0, #1, ···, #i-1, #i, AS DFL AND DDS, IN DEFECT MANAGEMENT AREA
1110
END